

## DEVELOPMENT AND PERFORMANCE EVALUATION OF ALOE

### VERA LEAF SLICING MACHINE

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#### ABSTRACT

*The Aloe plant belongs to a member of the family Liliaceae, which comprises more than 360 different species. Aloe Vera has a number of uses and mainly they are used as a food preservative and herbal medicine. In the manufacturing of whole leaf Aloe Vera powder, slicing is one of the important unit operations after trimming. Presently, manual slicing is most commonly followed in Indian Aloe industries, which is time consuming, tedious, unhygienic, expensive and sometimes hazardous. The design and development of Aloe vera leaf slicing machine is to solve the aforementioned problems. This machine mainly consist of belt conveyor, feed and conveyor roller, chain sprockets, knives, power transmission mechanism and frame. The performance evaluation of the machine was evaluated under three belt conveyor speed (0.251, 0.188 and 0.125 m. s<sup>-1</sup>) and three No. of knives (2, 4 and 8). It was found that 0.251 m. s<sup>-1</sup> belt conveyor speed with 8 No. of knives was optimized condition. The machine is simple in construction, easy to operate and does not require special skill. The results of the test carried out showed that the time required to slice equal length of Aloe vera with the machine is 24 times less than the manual process. This machine has sliced efficiency of about 90.46% with effective capacity of 648.21 kg. h<sup>-1</sup>.*

**KEYWORDS:** Aloe Vera Leaf, Slicing Machine, Slicing Efficiency and Slicing Capacity

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#### INTRODUCTION

The Aloe plant belongs to a member of the family Liliaceae, which comprises more than 360 different species. Recently, the family was given the name Aloaceae (Eshun and He, 2004). Aloe vera can be processed into various products like gel, extract, powder, juice, etc. Consumers can use Aloe vera externally and internally. Aloe vera is a medicinal plant that has many health benefits for its users. It is commonly used to heal and cleanse wounds. It has the ability to hydrate and soothe the skin and to reduce inflammation (Arunkumar and Muthuselvam, 2009).

In the manufacturing of whole leaf Aloe Vera powder, slicing is one of the important unit operations after trimming. Presently, manual slicing is most commonly followed in Indian Aloe industries, which is time consuming, tedious, unhygienic, expensive and sometimes hazardous. If the leaves are sliced by hand system, the obtained slices are not of uniform size. The processing of the Aloe vera plant for making whole leaf powder involves cleaning, washing, trimming, slicing and drying. Normally, the slicing of the Aloe vera leaves can be done manually, which is not at all accurate for further processing and so, the slicing machine for Aloe vera is required to increase the uniformity of the slicing, prevent the injury, reduce the damages, reduce the time, increase the slicing efficiency and reduce the labour cost. The uniformly sized slices obtained from the machine will give a uniform drying for further processing of whole leaf powder which is used in cosmetic and pharmaceutical industries.

Hence, there is a need for mechanization of Aloe vera leaf slicing process with reduced damage, increased hygiene and enhanced capacity. Considering the importance of slicing process, the possibility of mechanizing the process of Aloe vera leaf slicing becomes very necessary. An Aloe Vera leaf slicing machine will be therefore designed to mechanize the process of slicing Aloe Vera leaf for making whole leaf powder used for external application. It can be used in both pharmaceutical and cosmetic industries.

## **MATERIAL AND METHODS**

### **Design of Aloe Vera Leaf Slicing Machine**

The Aloe vera leaf slicing machine consisted of slicing head disc with knives, belt conveyor, power transmission system and feed rollers to gather, grip and advance the Aloe vera leaves into the slicing section and spring loaded feed roller was provided for different size and thickness of leaves. The machine was operated by an electric motor and power was transmitted to the Aloe vera leaf slicing machine through the bevel gear shaft *via* the gear box drive pulley. It was manually fed with 3-4 leaves at a time through the belt conveyor. The whole Aloe vera leaves were passed horizontally (facing tip) against the feed roller through belt conveyor and were sliced into small pieces.

### **Selection of Power Source**

The selection of suitable power source is very important while developing any type of agricultural processing machine. The selected motor speed was 1440 rpm and drive pulley speed was 102.85. This implies the speed reduction was calculated as 1:14.

### **Development of Aloe Vera Leaf Slicing Machine**

Based on the basic Engineering properties of Aloe vera leaf, a power operated Aloe vera leaf slicing machine was designed and developed. A brief description of its components is given below.

#### **Main Frame**

For supporting flywheel slicing head assembly and power transmission unit and belt conveyor, a rectangular frame was made of 40 mm × 40 mm × 5 mm MS angle iron. Correspondingly, the main frame length, width and height were 1100 mm, 400 mm and 700 mm, respectively. Same size of MS angle iron was welded across all the members of the frame to make it as a rigid frame. The main frame consisted of four legs, which supported the slicing disc head, power transmission unit, belt conveyor and electric motor with gearbox.

#### **Belt Conveyor**

The belt conveyor is the component of Aloe vera leaf slicing machine, which received the Aloe vera leaves and fed it to the feed rollers. The leaves were manually fed with 3-4 leaves horizontally on the belt conveyor at a time. The overall dimensions of the belt conveyor were 1050 mm × 300 mm × 3 mm length, width and thickness respectively.

#### **Shear Plate**

Shear plate at the stationary edge against which the slicing disc head knives sheared the Aloe vera leaf and it also helped to hold the Aloe vera leaf. It was provided in front of the feed rollers. It was made of stainless steel. The slicing clearance between the shear plate and knives was zero in order to maintain proper slicing action.

### Feed Roller and Conveyor Rollers

There was mainly one feed roller provided in front of belt conveyor. Two low tension springs were provided to the roller for the lifting of rollers for different sized leaves. It was made from hard rubber. And for easy movement of the belt, the two knurled rollers were provided. It was a metal type (mild steel) knurling roller. The leaves were passed through belt conveyor in between the front conveyor roller and feed roller, finally to the slicing section. Three chain sprockets were provided at the end of feed rollers for easy rotation

### Slicing Disc Head

#### Shape

The round slicing disc head is most commonly used in power operated machines. In this study, Aloe vera leaf slicing machine consisted of a round slicing disc head for slicing Aloe vera leaves. It had a round shaped slicing disc head with removable knives to slice materials into required size. The overall diameter of slicing disc head was 180 mm.

#### Direction of Rotation

The direction of rotation of slicing disc head in Aloe vera leaf slicing machine was similar to chaff cutter.

### Slicing Knives

The knife is an important component in the slicing disc head of Aloe vera leaf slicing machine. In this study, straight knives were used for slicing of Aloe vera leaves. The knives were removable and fixed to supporting plate and connected to slicing disc head using nuts and bolts to get better performance. The knives were made from stainless steel of food grade quality (SS 304). The overall dimensions of the knives were 350 mm × 30 mm × 5 mm length, width and thickness respectively. The isometric view, side view and top view of Aloe vera leaf slicing machine is shown in Figure 1, 2 and 3, respectively.

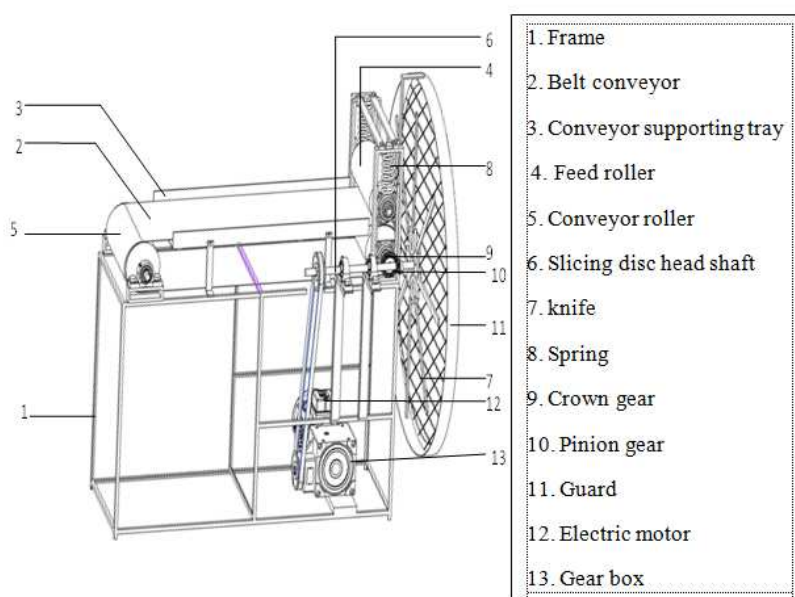
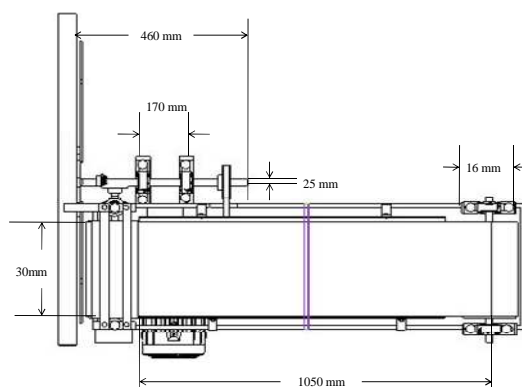
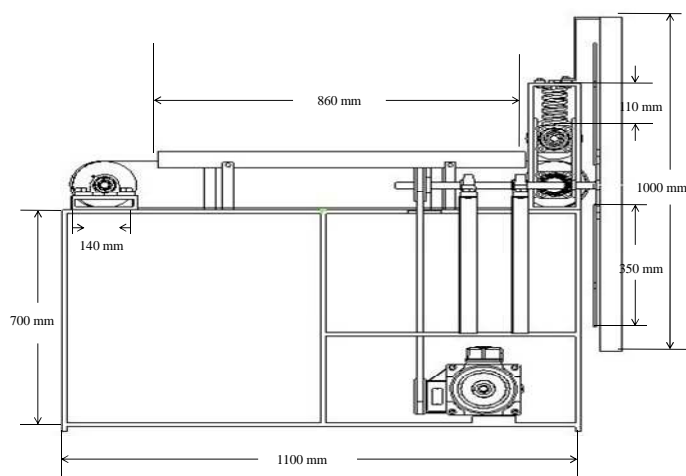


Figure 1: Isometric View of Aloe Vera Leaf Slicing Machine



**Figure 2: Top View of Aloe Vera Leaf Slicing Machine**



**Figure 3: Side View of Aloe Vera Leaf Slicing Machine**



**Plate 1: Power Operated Developed Aloe Vera Leaf Slicing Machine**

### Performance Evaluation of Aloe Vera Leaf Slicing Machine

The performance of Aloe vera leaf slicing machine was evaluated under laboratory conditions. The parameters such as slicing length, machine output capacity, power consumption, slicing efficiency were recorded during the laboratory tests. As there was no specific test code available for testing of Aloe vera leaf slicing machine, the pertinent parameters relevant to machine performance determination were measured.

#### Slicing Length

The slicing length of Aloe vera leaves mainly depended on the belt conveyor speed and number of knives used. The slicing length of Aloe vera after slicing operation was measured in mm by using plastic tape. The slicing length of Aloe vera was recorded randomly in the laboratory by laying a 1m<sup>2</sup> size frame.

#### Slicing Capacity

Slicing capacity is the quantity of Aloe vera sliced in a given time. The slicing capacity was calculated by using the following equation (Akande and Onifade, 2015).

$$S_c = \frac{W_T}{T}$$

Where,

$S_c$  = Slicing capacity (kg.h<sup>-1</sup>)

$W_T$  = Total weight of Aloe vera slices (kg)

$T$  = Time taken to slice Aloe vera leaves, (h)

#### Slicing Efficiency

The efficiency of Aloe vera leaf slicing was obtained in the required small pieces without any damage. The slicing efficiency was calculated by using the following equation (Sonawane *et al.*, 2011; Kamaldeen and Awagu, 2013; Akande and Onifade, 2015; Borkar *et al.*, 2015; Onifade, 2016).

$$\eta = \frac{W_T - W_D}{W_T} \times 100$$

where,

$\eta$  = Slicing efficiency (%)

$W_T$  = Weight of total slices (kg)

$W_D$  = Weight of damaged slices (kg)

#### Slicing Loss

Slicing loss is the measurement of effectiveness of the slicing operation of the machine. Slicing loss was calculated by following equation (Mishra *et al.*, 2013) and (Ayodeji *et al.*, 2014).

$$S_1 = \frac{W_1 - W_2}{W_1} \times 100$$

where,

$S_1$  = Slicing loss (%)

$W_1$  = Weight of Aloe vera before slicing (kg)

$W_2$  = Weight of Aloe vera after slicing (kg)

### Power Consumption

The power consumption of Aloe vera leaf slicing machine can be expressed by using the following equation (Shashikumar, 2015).

$$C_i = \frac{W_r}{C}$$

where,

$C_i$  = Power consumed ( $\text{kWh}^{-1} \cdot \text{kg}$ )

$W_r$  = Average wattmeter reading (kW)

$C$  = Capacity,  $\text{kg} \cdot \text{h}^{-1}$

## RESULTS AND DISCUSSIONS

The performance evaluation of developed Aloe Vera slicing machine was evaluated at 3 different belt conveyor speed and 3 No. of knives. The results are discussed below. The effect of belt conveyor speed and No. of knives on slicing length, slicing capacity, slicing loss, slicing efficiency and power consumption are shown in figure 1, 2, 3 and 4 respectively.

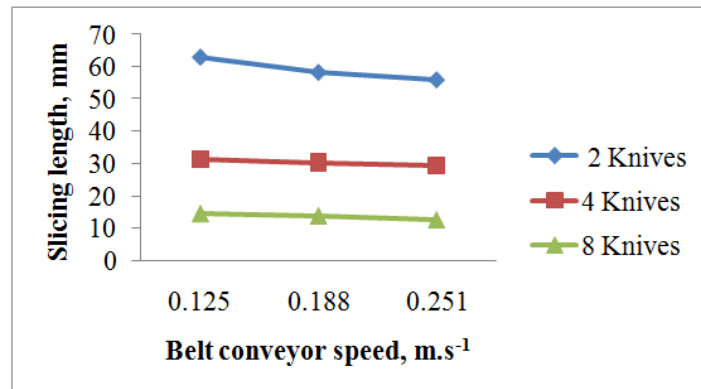


Figure 4: Effect of Belt Conveyor Speed and Number of Knives on Slicing Length (mm)

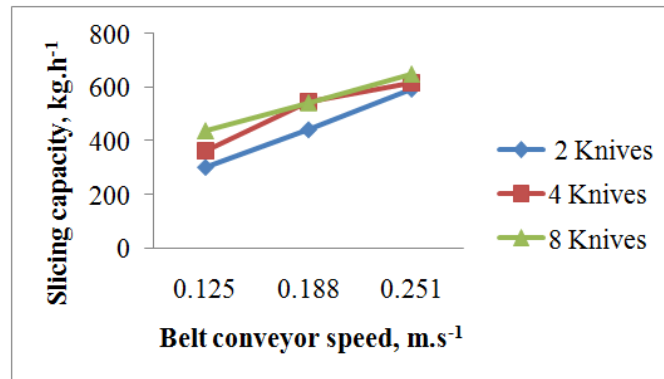


Figure 5: Effect of Belt Conveyor Speed and Number of Knives on Slicing Capacity (kg.h)

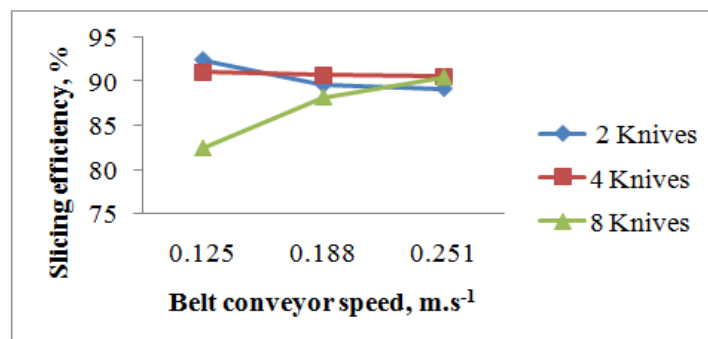


Figure 6: Effect of Belt Conveyor Speed and Number of Knives on Slicing Efficiency (%)

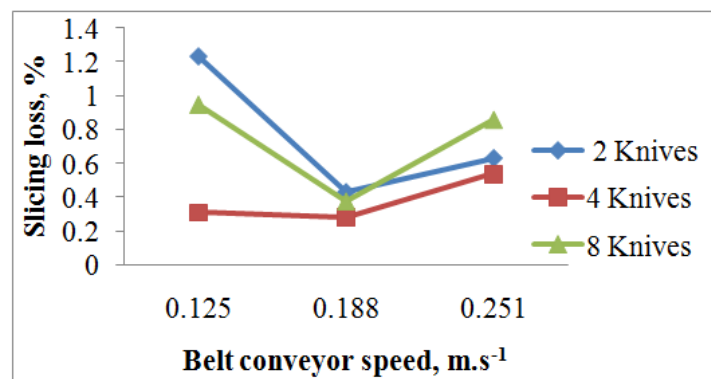
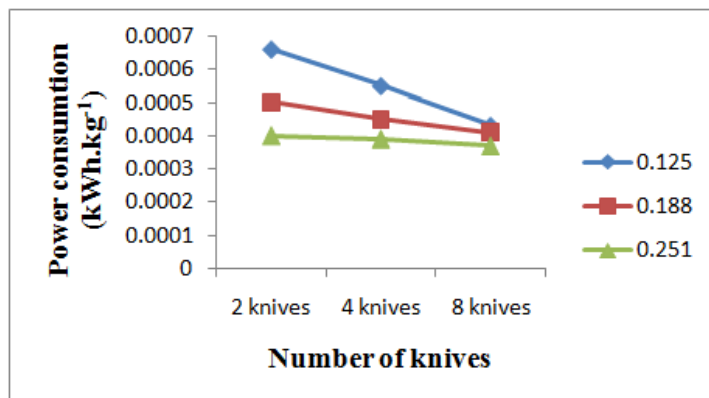


Figure 7: Effect of Belt Conveyor Speed and Number of Knives on Slicing Loss (%)



**Figure 8: Effect of Belt Conveyor Speed and Number of Knives on Power Consumption (kWh.kg<sup>-1</sup>)**

- The slicing length of Aloe vera leaf increased as the belt conveyor speed and number of knives decreased. Minimum slicing length was found at 0.251 m.s<sup>-1</sup> belt conveyor speed with 8 No. of knives whereas maximum slicing length was observed at 0.125 m.s<sup>-1</sup> belt conveyor speed with 2 No. of knives. The effect of belt conveyor speed and No. of knives on slicing length is shown in figure 1
- The slicing capacity of the machine increased as the belt conveyor speed and number of knives increased. Maximum is slicing capacity of Aloe Vera leaf slicing machine was observed at 0.251 m.s<sup>-1</sup> belt conveyor speed with 8 No. of knives and the minimum was observed at 0.125 m.s<sup>-1</sup> belt conveyor speed with 2 No. of knives. The effect of belt conveyor speed and No. of knives on slicing length is shown in figure 2
- The slicing efficiency of the machine increased as the belt conveyor speed and No. of knives decreased. Maximum is slicing capacity of Aloe Vera leaf slicing machine was observed at 0.125 m.s<sup>-1</sup> belt conveyor speed with 2 No. of knives and the minimum was observed at 0.125 m.s<sup>-1</sup> belt conveyor speed with 8 No. of knives.
- The slicing loss of machine decreased as the belt conveyor speed and number of knives decreased and it increased as the number of knives decreased. Minimum slicing loss of Aloe vera leaf slicing machine was observed at 0.125 m.s<sup>-1</sup> belt conveyor speed with 4 No. of knives and maximum loss was observed at 0.125 m.s<sup>-1</sup> belt conveyor speed with 2 No. of knives.
- The power consumption of Aloe vera leaf increased as the belt conveyor speed decreased and it decreased as the number of knives decreased. It was observed that the overall minimum power consumption was found for 8 No. of knives compared to 2 and 4 No. of knives. Maximum power consumption was found at 0.125 m.s<sup>-1</sup> belt conveyor speed with 2 No. of knives whereas minimum power consumption was observed at 0.251 m.s<sup>-1</sup> belt conveyor speed with 8 No. of knives.

## CONCLUSION

The overall dimensions of the machine were 1100 mm in length, 700 mm in height and 400 mm in width. The machine designed and developed and was capable of slicing the Aloe vera leaves in the form of thin uniform slices. The machine was simple in construction and operation with low cost. The capacity of the machine was 648.21 kg. h<sup>-1</sup> and efficiency was 90.42%. The production cost of the machine is ` 39000/- This mechanical method of slicing using the developmental machine is non hazardous, fast and hygienic compared to traditional manual slicing.



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